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13. ABSTRACT *(Maximum 200 words)*

Research was supported in inverse application areas of probability, ergodic theory and dynamical systems (including neural networks). Theorems on rates of learning in unsupervised Neural Networks, relating to the sampling method for available environmental data were obtained. Results on the consistency and effectiveness of estimators for correlation dimension were derived, together with advanced percolation structures useful in mammalian lung development models. Ways of using "continued fractions" to construct highly mixing stochastic processes were expounded.

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FINAL REPORT of AFOSR GRANT No. F49620-9310275 (1993 – 1996)
Awarded to Robert Burton, Department of Mathematics, Oregon State University.

This grant supported research in diverse areas of applications of probability, ergodic theory and dynamical systems.

Neural Networks have been a major thrust of this research. Publications 7, 12 discuss the possibility of learning in frustrated environments and the potential limits of neural network behavior. Publications 1, 6, 14 deal with unsupervised neural networks that imitate patterns within constraints automatically by sampling their environment. These theorems show that learning occurs exponentially quickly with probability one. Publication 13 uses neural networks and other estimation algorithms to predict the future of time series.

Fractals and Chaos were also investigated. Publication 8 analyzes a more flexible variant of Mandelbrot percolation and shows that complex patterns arise which are often highly disconnected. These were first suggested as models of lung development. The estimation of the dimension of a chaotic attractor was studied in publications 5 and 16. First it is shown that the most commonly used estimators of correlation dimension are consistent and effective. Limitations of these estimators are shown by examples together with suggestions for improvement.

Statistical and Symbolic Dynamics were reported on in publications 2, 4, 9, and 10. Publication 2 shows that it is possible for a stochastic process to be deterministic and yet show very random effects. Publications 4 and 10 show how the geometry of higher dimensions affects the randomness properties of a field. Publication 9 describes choosing a pair of random transformations using the language of cocycles.

Continued Fractions are a compact way of expressing real numbers that give optimal ways to approximate real numbers. They have been central examples in the development of probability and ergodic theory. Publications 3 and 15 describe new continued fractions and prove that they have strong arithmetic and mixing properties.

Publications supported by AFOSR GRANT No. F49620-9310275 (1993-1996)

1. Stability of self organizing processes. Pages 19-23 in D. Aldous and R. Pemantle, eds., Random Discrete Structures, IMA, Vol. 76, Springer-Verlag, New York, (1996) (with W. Faris).

2. Finite state, bilaterally deterministic, strongly mixing processes. Israel J. Math. 26(1996) (with M. Denker and M. Smorodinsky).

3. Ergodic properties of generalized Lüroth series. Acta Arith. 4(1996):311-327 (with J. Barrionuevo, K. Dajani, C. Kraaikamp).

4. Some 2-D symbolic dynamical systems: entropy and mixing. Pages 297-305 in M. Pollicott and K. Schmidt, eds., Ergodic Theory of Z^d Actions, Proceedings of 1994 Warwick Conference on Statistical Mechanics, (1996), Cambridge University Press, Cambridge (with J. Steif).

5. Strong laws of large numbers for L- and U- statistics. Trans. Amer. Math. Society 348(1996):2845-2866 (with J. Aaronson, H. Dehling, D. Gilat, T. Hill and B. Weiss).

6. A self-organizing cluster process. Ann. App. Probab. 6(1996):1232-1247 (with W. Faris).

7. Perception algorithms for the classification of non-separable populations. Stochastic Models 13(1997):1-14 (with H.G. Dehling and R.S. Venema).

8. Fractal percolation with neighbor interaction. Pages 106-114 in J.L. Véhel, E. Lutton, and C. Tricot, eds., Fractals in Engineering, (1997), Springer, London, (with T. Coffey, M. Dekking, and K. Hyman).

9. Entropy for random group actions. To appear in Ergodic Theory and Dynamical Systems. (with K. Dajani and R. Meester).

10. Coupling surfaces and weak Bernoulli in one and higher dimensions. To appear in Adv. Math. (with J. Steif).

11. Second order Dehn functions of direct products of groups. To appear in Oxford J. Math. (with J. Alonso, W. Bogley, S. Pride, X. Wang).

12. Universal approximation in p-mean by neural networks. To appear in Neural Networks (with H. Dehling).

13. Prediction of nonlinear time series by kernel regression smoothing. To appear in the First European Conference on Signal Analysis and Prediction (with S. Borovkova and H. Dehling).

14. One dimensional Kohonen maps are super stable with exponential rate. Submitted (with D. Plaehn).

15. Natural extensions for Rosen fractions. Submitted (with C. Kraaikamp and T. Schmidt).

16. Consistency of the Takens estimator for the correlation dimension. Submitted (with S. Borovkova and H. Dehling).